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PARALLEL PRINTER INTERFACE CARD

INSTALLATION AND OPERATING MANUAL

TM

Apple Intelligent Subsystem

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APPLE II
PARALLEL PRINTER
INTERFACE CARD (A2B0002X)
INSTALLATION AND OPERATING MANUAL

PLEASE READ THIS MANUAL BEFORE ATTEMPTING TO INSTALL THE PRINTER INTERFACE CARD INTO THE APPLE II. INCORRECT WIRING COULD CAUSE PERMANENT DAMAGE TO BOTH THE PRINTER INTERFACE CARD AND THE APPLE II.

MANUAL NO. A2L0004X REV. A 1/78

PARALLEL PRINTER INTERFACE CARD
INSTALLATION AND OPERATING MANUAL

TABLE OF CONTENTS

SECTION	TITLE	PAGE
	INTRODUCTION	3
I	INTERFACING TO THE PRINTER	5
	Connecting The Cable	
	Wiring The Jumper Block	
II	INSTALLING THE PRINTER CARD	13
III	PRINTER OPERATION	15
	Accommodating Different Printers	
	Starting To Use Your New Printer	
	Printer Commands	
IV	USING THE PRINTER CARD AS A GENERAL-PURPOSE, PARALLEL OUTPUT PORT	21
V	HARDWARE DESCRIPTION	23
	Introduction	
	Handshake Procedure	
	Schematic	
VI	FIRMWARE DESCRIPTION	29

APPLE II PARALLEL PRINTER INTERFACE CARD

INTRODUCTION

The Parallel Printer Interface Card allows the Apple II to produce hardcopy (printed) output on a wide variety of printers. This compact board not only provides a complete electronic link between the printer and the Apple II motherboard, but in addition it contains a powerful firmware package to handle:

- Interpretation of program commands for the printer,
- Compensation for varying printer line lengths,
- Special control characters peculiar to a given printer.

Using this built-in subroutine package, a user can easily control the printer from BASIC or the Monitor, to produce:

- Program listings
- Printed records and reports
- Debug listings and memory dumps

The Interface Card can be quickly adapted to most printers equipped with a 7- or 8-bit parallel interface. It can operate them at speeds up to 5000 char/second (3700 lines/minute at 80 char/line), or the maximum rated speed of the printer--whichever is lower. It can print 40 to 255 characters/line, determined by the printer.

The Printer Card is also useful in non-printer applications as a general purpose, 8-bit parallel output port. See Section 4 for information on using the board in this mode.

I INTERFACING TO THE PRINTER

The Apple II Parallel Printer Card is designed to interface with a variety of printers; but the user must "customize" it to interface with the selected printer by:

1. Connecting the ribbon cable (delivered with the Parallel Printer Card) to the proper connection points in the printer, and;
2. Wiring the jumper configuration block for the "handshake" (communications) procedure recognized by the printer.

Connecting the Cable

The twenty-wire interconnecting cable is illustrated at the end of this section. Ten to twelve wires (depending on the selected printer) must be connected to the printer. Cable connector diagrams for the Axiom EX800, the Centronics, and the SWTP PR40 printers are given on the pages following the cable illustration. For all other printers, use the twenty-wire cable illustration (Figure 2) and the interconnect information in the printer manufacturer's manual to develop your connector diagram (use the form in Figure 6). Connect the wires in the following order:

Step		Cable Wire(s)	
1	Connect **both** Grounds	1 & 20	to the printer "circuit" or " logic" ground pins. (Do not use "chassis" or "AC" ground)
2	Connect Data Lines	10-17	to the appropriate data input pins in the printer.

Notes: Data Line DP0 (cable wire 10) must go to the lowest numbered signal name (Least Significant Bit) in the printer. The lowest signal name is usually number 0; but it may be number 1, depending on the printer. (The printer signal names, which are specified in the printer manual, may not correspond to the connector pin numbers, so go by the signal names.)

Data Lines DP1-DP7 (cable wires 11-17) connect to sequentially higher numbered printer signal names. Some printers only utilize seven data lines (e.g. Axiom and PR40). Other printers utilize eight data lines (e.g. Centronics). If only seven data lines are utilized, leave printer cable wire 17 (DP7) unconnected.

3	Connect ACK	2	to the printer output pin.

Notes: ACK (ACKnowledge) should be connected to the printer output pin (labeled ACK, DATA ACCEPTED, or a similar name) which denotes the printer accepting data from the interface card.

Either ACK or $\overline{\text{ACK}}$ polarity is acceptable, depending on the configuration of the jumper block.

Step		Cable Wire(s)	
4	Connect STROBE	8	to the printer input pin.

Notes: STROBE should be connected to the printer input pin (labeled STROBE, DATA READY, or a similar name) which denotes the interface card telling the printer that data is ready for acceptance.

Either STROBE or $\overline{\text{STROBE}}$ polarity is acceptable, depending on the configuration of the jumper block.

5 Tape all unconnected wires from the cable to avoid unintentional shorts.

Wiring the Jumper Block

The jumper configuration block must be wired for the "handshake" procedure the printer recognizes. To wire the jumper block, take the following steps:

Step

1 Locate the jumper block (in the lower right corner of the Parallel Printer Board-location B1).

2 Note the position of the jumper block in location B1. The upper left corner of the jumper lock is notched, denoting pin #1. The jumper block must be re-inserted so the notched upper left corner matches the notched upper left corner of the socket.

3 Remove and wire the jumper block.

Notes: Wiring diagrams for the Axiom, Centronics, and SWTP PR40 printers are illustrated at the end of this section.

For all other printers, take the following steps:

A. Determine whether the printer requires STROBE (positive-going) or $\overline{\text{STROBE}}$ (negative-going) strobe edge.

B. Determine whether the printer output is an ACK (negative-going) or an $\overline{\text{ACK}}$ (positive-going) signal edge.

C. Select the diagram in Figure 1 below that matches the STROBE/ACK "handshake" determined in A and B above.

D. Wire the jumper block according to the appropriate diagram.

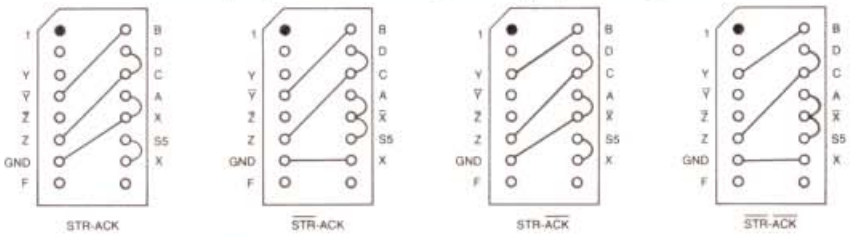
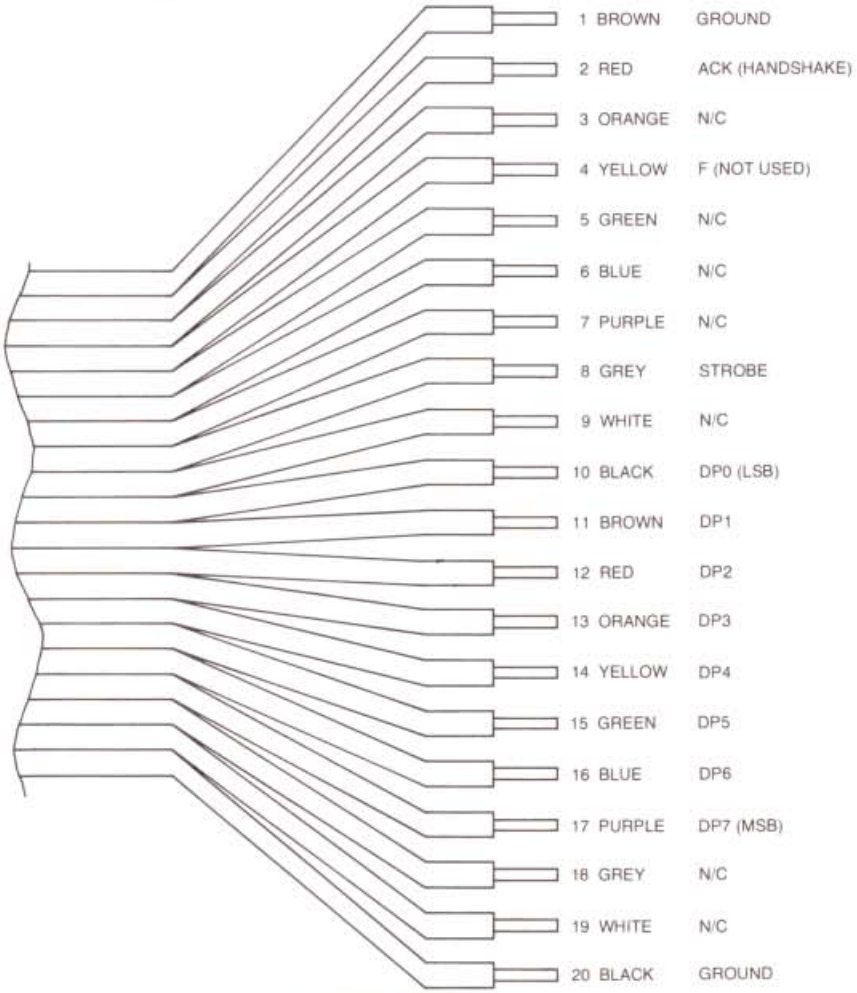


Figure 1. Jumper Block Diagrams

The STROBE/ACK specifications are usually found in the manual describing the printer. The names used to identify STROBE and ACK signals may vary.

If the STROBE/ACK signals are not defined, as a last resort try each wiring diagram in Figure 1. The Apple II will control the printer properly when the correct configuration is found. (Attempting to use the printer with an incorrect configuration will not damage the printer or the Apple II.)

4 Re-insert the jumper block in location B1 on the Parallel Printer Card. The notched upper left corner of the jumper block must match the notched upper left corner of the socket.



1 N/C = NO CONNECTION
2 LSB = LEAST SIGNIFICANT DATA BIT OUT
3 MSB = MOST SIGNIFICANT DATA BIT OUT

Figure 2. Interconnecting Cable Diagram

Cable Connector Table

Axiom EX800 Printer

The Axiom EX800 uses a DB-25 male connector (ITT-Cannon Part #DB25P). The DB-25 male connectors are widely used in RS-232 interface devices.

Apple II	Printer Board Pin	Wire Color	EX800 Pin
GND	1	Brown	7
ACK	2	Red	14
STR	8	Grey	24
DP0	10	Black	15
DP1	11	Brown	16
DP2	12	Red	17
DP3	13	Orange	18
DP4	14	Yellow	19
DP5	15	Green	21
DP6	16	Blue	23
GND	20	Black	7

Jumper Configuration Block Wiring Diagram

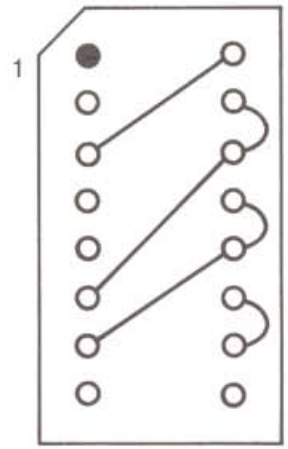


Figure 3. Axiom EX800 Example

Cable Connector Table

Centronics Printers

All standard Centronics printers use the same interface. Centronics printers require an Amphenol type 47, part #47-30360 connector.

Apple II	Printer Board Pin	Wire Color	Centronics Pin
GND	1	Brown	14
ACK	2	Red	10
STR	8	Grey	1
DP0	10	Black	2
DP1	11	Brown	3
DP2	12	Red	4
DP3	13	Orange	5
DP4	14	Yellow	6
DP5	15	Green	7
DP6	16	Blue	8
DP7	17	Violet	9
GND	20	Black	16

Jumper Configuration Block Wiring Diagram

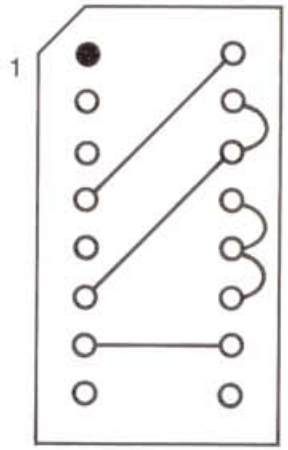


Figure 4. Centronics Example

Cable Connector Table

SWTP PR40 Printer

The SWTP requires a Molex receptacle, #03-09-1122. The connector uses both male and female pins and is wired as follows:

Apple II	Printer Board Pin	Wire Color	PR40 Pin	PR400 Pin Type
GND	1	Brown	1	Female
ACK	2	Red	2	Female
STR	8	Grey	3	Male
	—	N.C.	4	Female
DP5	15	Green	5	Female
DP6	16	Blue	6	Female
	—	N.C.	7	Male
DP3	13	Orange	8	Female
DP4	14	Yellow	9	Female
DP0	10	Black	10	Female
DP1	11	Brown	11	Female
DP2	12	Red	12	Male
GND	20	Black	1	Female

Jumper Configuration Block Wiring Diagram

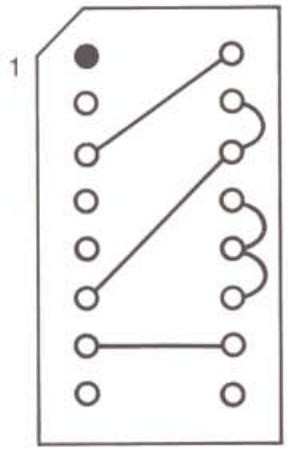


Figure 5. SWTP Example

Cable Connector Table

User's Printer Worksheet

Apple II	Printr Board Pin	Wire Color	Printer Pin
GND	1	Brown	_____
ACK	2	Red	_____
STR	8	Grey	_____
DP0	10	Black	_____
DP1	11	Brown	_____
DP2	12	Red	_____
DP3	13	Orange	_____
DP4	14	Yellow	_____
DP5	15	Green	_____
DP6	16	Blue	_____
GND	20	Black	_____

Jumper Configuration Block Wiring Diagram

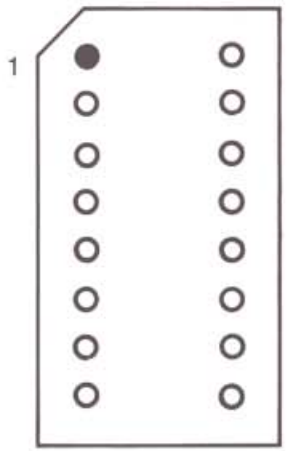


Figure 6. User's Cable and Configuration Block Diagram

II INSTALLING THE PRINTER CARD

To install the Parallel Printer Card, take the following steps:

Step

1 Turn the Apple II off.

Note: Power should always be off when inserting or removing a card. If the power is on, removal or insertion of a card could cause permanent damage to both the card and the Apple II.

2 Take off the lid and look at the row of eight connectors at the rear. Each connector is numbered (0-7) just in back of the connector. The numbered connectors are called slots.

3 Plug the Parallel Printer Card into any slot except slot #0.

Note: Slot #0 is reserved for future expansion and cannot be utilized by the Parallel Printer Card.

We recommend that you plug the card into slot #1, because the commands in the following section use slot #1.

When you sit at the keyboard, the component side of the Printer Card will be to your right when you insert it.

4 Gently plug the 20-pin flat cable connector into the mating connector on the Parallel Printer Card.

Note: The connector should be inserted so the flat cable comes out of the connector away from the board (not next to the board).

5 Drape the cable over the back of the case (with the lid off) and put the lid on.

Note: The pressure between the lid and the case acts as a cable clamp, preventing a tug on the cable from putting stress on the connector or Parallel Printer Card.

6 Plug the other end of the cable into the printer I/O connector.

III PRINTER OPERATION

Accommodating Different Printers

Interpretation of Carriage Return and Line Feed character sequences varies from printer to printer. The following table summarizes the possible interpretations.

Method	Character Interpreted	Action
1	Carriage Return	Causes carriage return and advances line.
	Line Feed	Causes no action.
2	Carriage Return	Causes carriage return.
	Line Feed	Advances line.
3	Carriage Return	Causes no action.
	Line Feed	Causes carriage return and advances line.
4	Carriage Return	Causes carriage return and advances line.
	Line Feed	Advances line.

The Apple II adds a Carriage Return to the end of every line, and; the Parallel Printer Card adds a Line Feed character to the end of each line.

Therefore, each line sent to the printer is terminated by a Carriage Return and a Line Feed.

If the printer automatically adds another Line Feed character to the end of each line, double spacing of the printed lines may occur. If desired a command described below may be used to turn off the automatic printer Line Feed.

The number of columns (characters) per line also varies from printer to printer. When using a printer with a TV monitor, the line width is set to 40 columns, the width of the TV monitor. When using the printer alone, the line may be set to any width from 40 to 255 columns (depending upon the printer's capacity). The Parallel Printer Card is configured to accommodate the following Apple BASIC conventions:

- BASIC Listings will be formatted to prevent splitting command words at the end of the line.
- The TAB command and PRINT "comma" command formats will be printer dependent, regardless of line width.

In other words, setting the line width also sets the TAB, PRINT "comma," and BASIC Listing conventions to accommodate the new line width.

Starting to Use Your New Printer—An Example

Once the Parallel Printer Card is configured to match the printer and installed in a slot, it is ready for use.

The Printer Commands in the examples below are in Apple II BASIC. Apple Monitor I/O Commands and Apple Basic Program I/O Commands are listed at the end of this section.

Command	Explanation
RESET B^C RETURN	Interrupts any program execution and transfers control to BASIC.
> PR#1	Turns Parallel Printer Card on. All data displayed on the TV monitor screen is also sent to the printer with the following exceptions: • Graphic data is not printed • Backward TABs and VTABs do not work. (Forward TABs work correctly.) Notes: I/O slot 0 cannot be entered. If the incorrect slot number is typed, all output will go to the wrong slot and no data will be displayed or printed. Depress RESET, and the computer will return to TV monitor display only. If the printer is not plugged in, turned ON, and ready to print, it will look BUSY to the system; which will "hang up" waiting for it. To clear this waiting state, get the printer ready to print (see its manual), then depress Apple II's RESET key (to clear the busy flag). The program may then be re-started.
>PRINT 6+7 RETURN	The statement and its result should appear on both the printer and the monitor screen. Notes: Most printers wait for a Carriage Return and then print the entire line. Since the TV monitor display is designed for 40 characters per line, the printer will behave like a 40 column (40 characters per line) printer as long as the monitor screen display is on. On some printers, several lines must be printed before the paper advances far enough for the first line to be seen.

If at this point, data does not print at the printer:

1. Verify the Parallel Printer Card is plugged into slot #1 (specified in the PR#1 command). Slot #1 is the **second** slot from the left.

2. Verify that the wiring of the cable and jumper block are correct.
3. Verify that PR#1 was typed correctly.
4. Verify that the printer is turned on, and that the system has been RESET since.

If the printer still does not print, ask your local Apple dealer for assistance.

Printer Commands

The Parallel Printer Card Commands begin with CTRL I (I^C). The command conventions are:

LOWER CASE WORDS	Enter the data identified by the word.
UPPER CASE CHARACTERS	Type the character(s) or number(s) shown.
CONTROL CHARACTERS	Control characters are indicated by a superscript C; e.g.: I^C. A control character is entered by depressing the CTRL key and the character key simultaneously. (Similar to using the shift key to type a capital letter.)
SPACING	Spacing in the command format is for legibility only. Spaces are not required when the command is entered.

For example, I^Cno N RETURN means:

1. Type I while holding the CTRL key down.
2. Enter a number at the keyboard.
3. Type N at the keyboard.
4. Depress RETURN.

The Printer Commands are shown below. They may be used in the command mode from either BASIC or the Monitor (except for PR# and P^C commands—see explanations).

Command	Explanation
I^C n N RETURN	Turns off monitor screen and prints n columns per line on printer. The number of columns may be any number from 40 to 255.
I^C I RETURN	Returns output to TV monitor screen as well as to printer.
I^C K RETURN	Turns off automatic printer Line Feed.

I^C letter^C RETURN	Changes printer command control character recognized by printer. For example I^C A^C changes the control character recognized by the printer.
letter^C I^C RETURN	Changes printer control character back to I^C. For example, A^C I^C.
PR# slot no. RETURN	Turns Printer Card on from BASIC. The slot number must identify the slot in which the Parallel Printer Card is inserted. Any number from 1 to 7 may be entered.
PR#0 RETURN	Turns the Parallel Printer Card off from BASIC.
slot no. P^C	Turns on Printer Card from the Monitor. The slot number must identify the slot in which the card is inserted.
0P^C	Turns the Printer Card off from the Monitor.

Notes: For users of Applesoft BASIC on cassette tape:

Applesoft BASIC does not yet allow "PR#" commands (which are used in Apple Integer BASIC to turn the printer ON and OFF). Therefore, the printer must be controlled as follows:

To turn ON, type

POKE 54, 0: POKE 55, 192 + slot no.

To turn OFF, type

POKE 54, 240: POKE 55, 253

These commands must be entered on a single line, as shown. They will work from the Monitor and Apple BASIC as well as from Applesoft BASIC, but are not required.

All other commands, using I^C, work from Applesoft BASIC.

Using Printer Commands in BASIC Programs

Printer control within BASIC programs is accomplished by embedding the commands (shown above) in PRINT statements.

>10 PR#1	Turns off Printer Card.
>20 PRINT "I^C no. N";	Turns off TV monitor screen display and prints n columns per line at the printer
>30 PRINT "I^C I";	Returns output to TV monitor screen as well as printer.
>40 PRINT "I^C K";	Turns off the Line Feed code.
>50 PRINT "I^C A^C";	Changes I^C to A^C for printer listing of BASIC program.

>60 PRINT "A^C I^C";	Restores I^C as the printer control command character.

Example Of Control From a BASIC Program

Here is a typical BASIC program using the printer control commands.

10 PR #1	Turn on Printer Card.
(20 PRINT "I^C K";)	Only if printer advances line on Line Feed code.
30 PRINT "I^C 80 N";	Output on printer only.
40 PRINT "PRINTER"	
50 PRINT "I^C I";	Output on screen and printer.
60 PRINT "SCREEN AND PRINTER"	
70 PR #0	Turn off printer card.
80 PRINT "SCREEN ONLY"	
90 END	

Listing Programs Containing Print Commands

To list a BASIC program containing printer control commands, take the following steps:

Command	Explanations
> PR#1	Turns Parallel Printer Card on.
>I^C K RETURN	Only if printer avances line on Line Feed code.
>I^C A^C RETURN	Changes I^C character to A^C character. The printer treats I^C command sequences in a BASIC Program listing as a command and changes printer operation as specified in the command. To avoid this problem the I^C must be changed to another character, e.g.: A^C.
>A^C 80 N RETURN	Turns off TV monitor screen and outputs on 80 column printer.
>LIST	LIST is not displayed because the TV monitor display is off.
>A^C I^C RETURN	Enter after the listing is complete to restore I^C as the printer control command character.

OPERATING HINTS

The three techniques detailed below will guard against the most common printing problems.

1. Before using the printer in your program (PR#1 statement), be sure to HOME the cursor and clear the screen. (A CALL-936 statement in your program does this.)
2. If you are printing more than 40 characters per line, be sure to re-set the line length to 40 characters per line before using the PR#0 command (which turns off the printer interface).
3. Before using the printer to list a program that has printer control commands embedded in it, change the control character from I to some other character. Then re-set I as the control character before running the program.

IV USING THE PRINTER CARD AS A GENERAL-PURPOSE, PARALLEL OUTPUT PORT

The Parallel Printer Card can be used as a general-purpose, 8-bit parallel output card to drive music synthesizers, digital-to-analog converters, etc.

If data is stored at location $C080+$N0 (where N is the slot number), then the data will appear on Printer Board Data Lines (DP0-DP7), and will remain until the next "STORE" instruction to that location is executed.

From BASIC this data transfer may be accomplished by typing:

POKE (−16256+N16), DATA

N is the slot number of the Printer Card, and DATA is the Data to be put out.

Each time a byte is sent to the Printer Card, a strobe will be generated on the STR line. The strobe polarity may be set as described earlier for strobes to printers.

V HARDWARE DESCRIPTION

Board Layout

The Printer Board contains a 6309 (256 × 8) PROM for printer firmware, an 8-bit data register, and handshake and configuration logic at the following board locations:

Location	Package Component	Function
B1	16-Pin DIP Header	Sets handshake logic levels.
B2	74LS74	Forms response detection from printer.
B3	74LS298	A. Two bits of 8-bit register are latched into two sections. B. An output strobe or level for handshake is formed using the other two sections.
A4	74LS174	Six bits of 8-bit data register latched into 74LS174.
A1	74LS00	Performs PROM address alteration. (A response signal alters the address range of the PROM; thus altering the firmware program.)

Handshake Procedure

The Parallel Printer Interface Card will accommodate a variety of handshake procedures. The following description of the more common two-line handshake should enable the engineer/user to design other handshake procedures.

STROBE/Edge Handshake

Pulse (STR or $\overline{STR}$) to printer indicates data transfer ready. Edge (ACK or $\overline{ACK}$) response from printer indicates printer ready to accept data.

Note: Although many printer documents describe the acknowledge signal as a level, careful inspection will often show the critical timing of the acknowledge signal to be on edge.

The Strobe/Edge Handshake is the most common handshake. Figure 7 illustrates the relative timing and defines the level for the handshake signals.

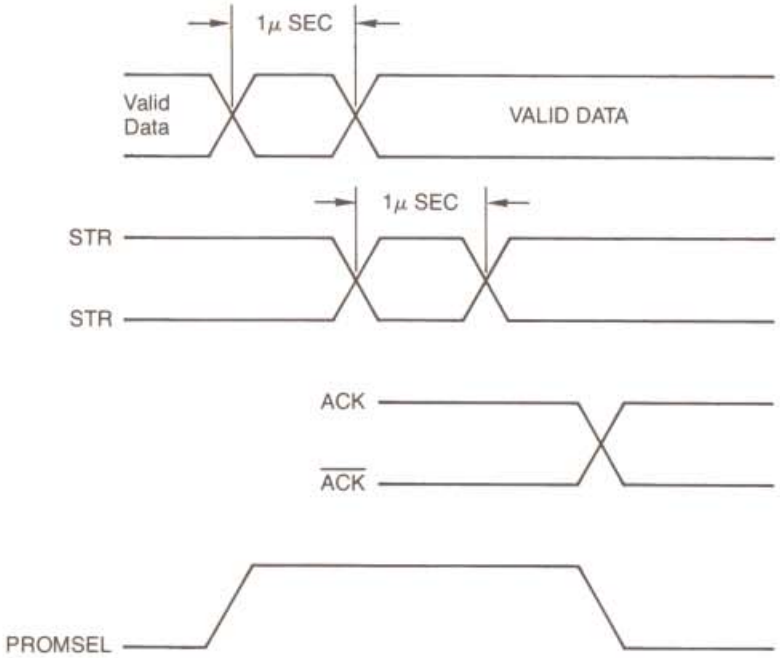
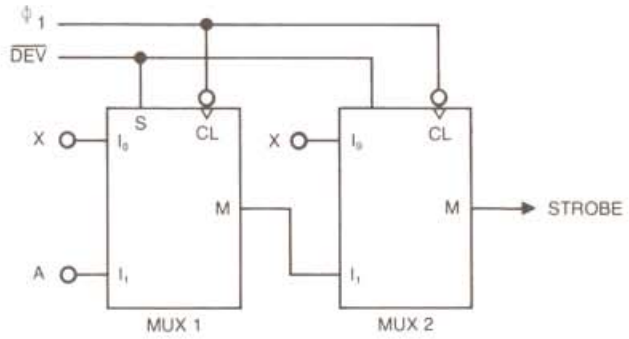


Figure 7. Strobe/Edge Timing

In Figure 8, FF1 is used to synchronize the incoming ACKnowledge signal to the Apple II system timing. The output of FF1 is connected to the clock input of FF2 to reset FF2 when the desired acknowlege edge occurs. (FF2 has been previously set by the DEV signal that occured when the last data was sent to the printer.) Thus, output Z (Q of FF2) will be high causing PROMSEL to be low from the time a data word is sent until the acknowledge edge is received. When PROMSEL is low, the PROM is in its Printer-Not-Available program mode.

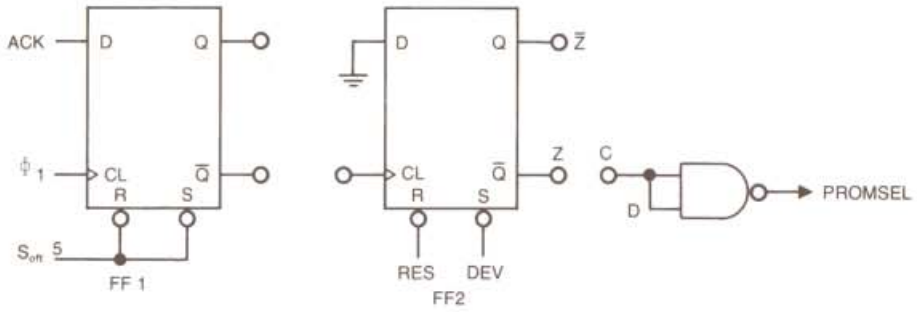
When a data word is sent to the printer, MUX1 will switch from the A input to the X input. (These are complementary for a strobe pulse response.) Thus, output M1 of MUX1 will change state. Since X is sent to the same state as A, the output STR of MUX2 will not change state with the DEV signal. On the next Φ_1 clock, STR will return to its rest state, completing the STR pulse generation. The deliberate delay in STR from the first DEV input is necessary because an indexed store operation from the 6502 will cause a false DEV the cycle prior to the legitimate store operation. Figures 9 and 10 show a functional block diagram of the Printer Card, and the actual schematic.



Strobe Pulse

$\overline{STR}$ A = S_{oft} 5
X = S_{oft} 5
X = GND

STR A = GND
X = GND
X = S_{oft} 5



Edge Response

$\overline{ACK}$: B = Y ACK: B = $\overline{Y}$

Figure 8. Jumper Configuration Block Connections

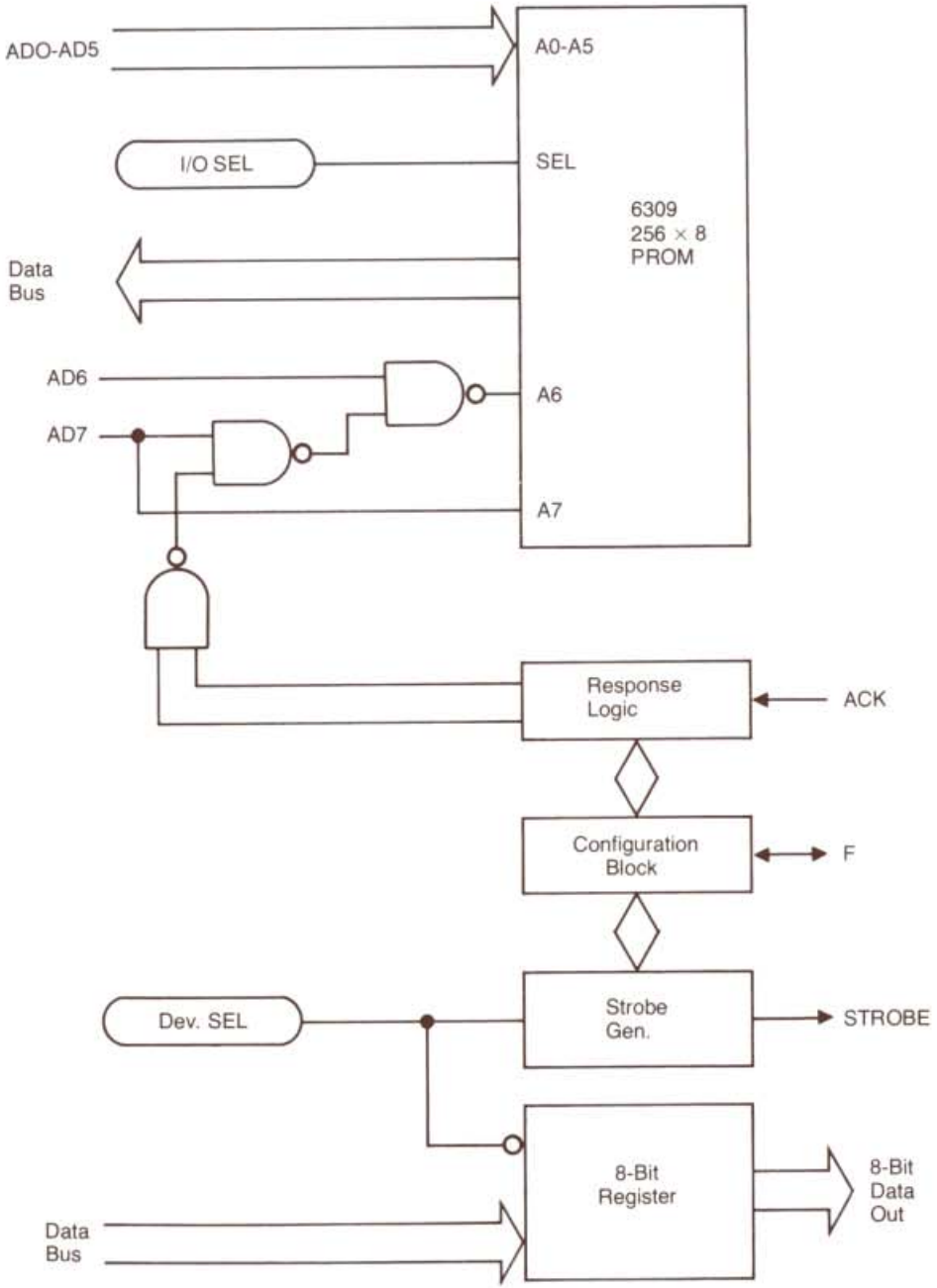


Figure 9. Parallel Printer Board Block Diagram

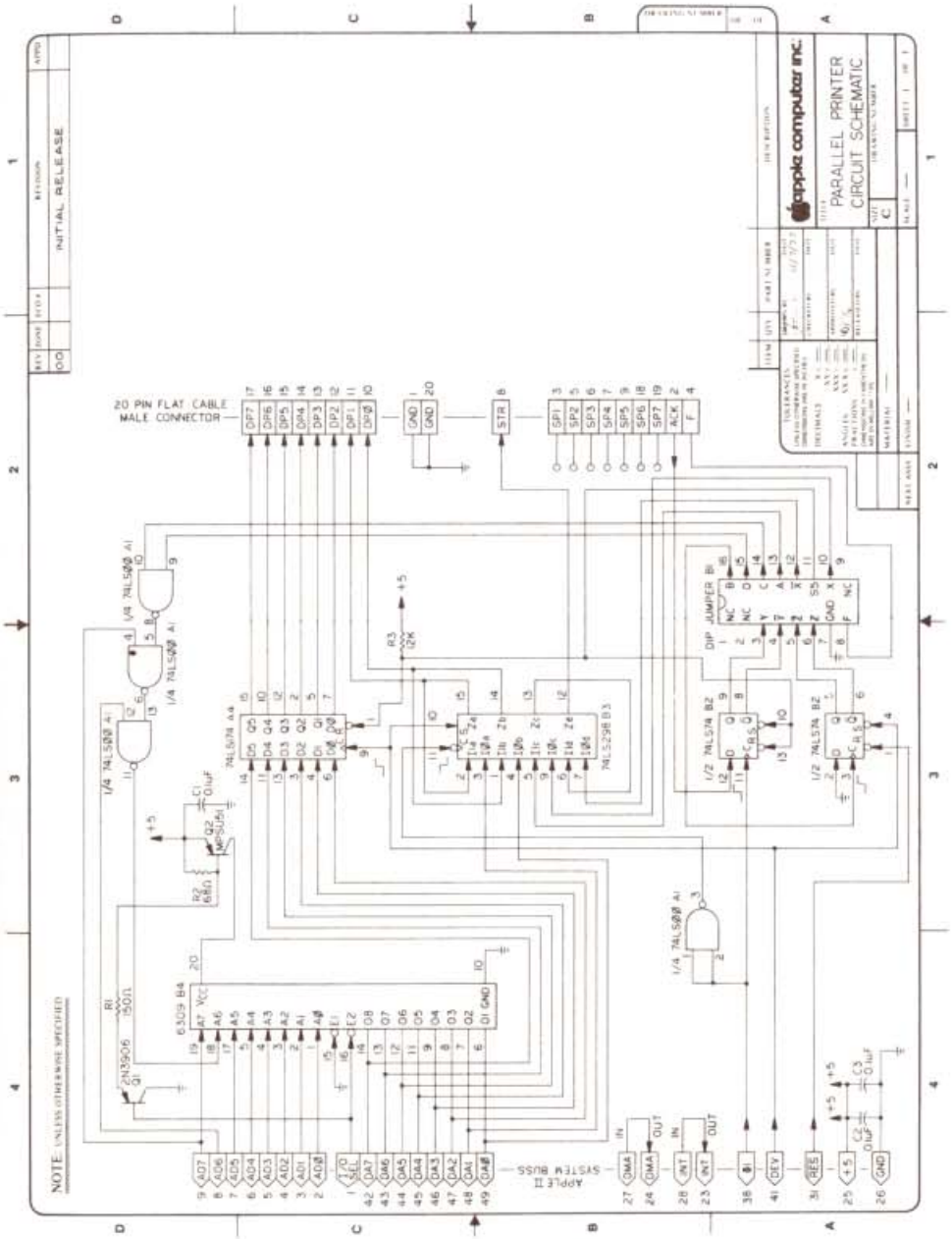


Figure 10. Parallel Printer Card Schematic

VI FIRMWARE DESCRIPTION

The commented firmware listing on the following pages fully describes the Apple II Parallel Printer Interface Card Firmware. The listing contains four sections:

- Address Transformation Information

  Note: The Firmware lisiting provides the apparent address of the printer card to the CPU. Due to address mapping, the apparent address and the real PROM address do not agree.

- Printer Card Equates
- Printer Card Firmware Listing
- Symbol Cross - Reference Table

The PR# BASIC Command or the P^C Monitor Command are not required to access the printer board firmware.

For direct output,

a) preset MSTRT ($5F8+$N)
   MODE ($678+$N)
   ESCHAR (6F8+$N)
   FLAGS ($778+$N)

b) enter the program once at $CN00. (The normal entry point is $CN02).

Data in the accumulator is output on the data lines with STR when the responding device is ready.

The firmware program exits by an RTS or a JMP COUT1, depending on B7 of the MODE word in memory. The accumulator, X and Y registers, and stack pointer are not affected.

```
0000                    0010 ********************************
0000                    0020 *                              *
0000                    0030 *   PRINTER CARD I FIRMWARE    *
0000                    0040 *                              *
0000                    0050 *        WOZ   11/1/77         *
0000                    0060 *     APPLE COMPUTER INC.      *
0000                    0070 *     ALL RIGHTS RESERVED      *
0000                    0080 *                              *
0000                    0090 ********************************
0000                    0100 WNDWDTH EQU   $21      WINDOW WIDTH (MARGIN)
0000                    0110 CH      EQU   $24      CURSOR HORIZONTAL INDEX
0000                    0120 CSWL    EQU   $36      LOW ORDER COUT SWITCH BYTE
0000                    0130 MSTRT   EQU   $538     MARGIN START
0000                    0140 MODE    EQU   $5B8     AFTER ESC CHAR IN B7
0000                    0150 ESCHAR  EQU   $638     CURRENT ESC CHAR
0000                    0160 FLAGS   EQU   $6B8     B7=VID-ALSO, B0=CRLF
0000                    0170 COL     EQU   $738     COLUMN COUNT
0000                    0180 DEV     EQU   $C080    +$N0 ACTIVATES THE DEV LINE
0000                    0190 COUT1   EQU   $FDF0    VIDEO OUTPUT ENTRY
0000                    0200 IORTS   EQU   $FF58    FIXED RTS INSTUCTION
0000                    0210 *
0000                    0220 *
0000 18            2    0230 ENTO    CLC           DEFAULT ENTRY
0001 B0 00         2*   0240         BCS   *
0003                    0250         ORG   *-1
0002 38            2    0260 ENT1    SEC           NORMAL ENTRY
0003 48            3    0270         PHA
0004 8A            2    0280         TXA
0005 48            3    0290         PHA           SAVE REGISTERS ON STACK
0006 98            2    0300         TYA
0007 48            3    0310         PHA
0008 08            3    0320         PHP
0009 78            2    0330         SEI           DISABLE INTERUPTS
000A 20 58 FF      6    0340         JSR   IORTS    RETURNS $CN ABOVE STACK
000D BA            2    0350         TSX             (N IS SLOT NUMBER)
000E 68            4    0360         PLA
000F 68            4    0370         PLA
0010 68            4    0380         PLA
0011 68            4    0390         PLA
0012 A8            2    0400         TAY           CHAR TO Y-REGISTER
0013 CA            2    0410         DEX
0014 9A            2    0420         TXS           GET $CN FROM ABOVE STACK
0015 68            4    0430         PLA
0016 28            4    0440         PLP           RESTORE STATUS
0017 AA            2    0450         TAX           $CN TO REG X
0018 90 47         2*   0460         BCC   DEFAULT
001A BD B8 05      4*   0470         LDA   MODE,X  AFTER ESC CHAR?
001D 10 4E         2*   0480         BPL   ESCTST    NO...
001F 98            2    0490         TYA             CHAR TO REG-A
0020 29 7F         2    0500         AND   #$7F      MASK OUT BIT 7
0022 49 30         2    0510         EOR   #$30      ALTER BITS
0024 C9 0A         2    0520         CMP   #$A       "0"-"9"?
0026 90 29         2*   0530         BCC   DIG       BRANCH IF YES
0028 C9 78         2    0540         CMP   #$78      "H"-"0"?
002A B0 06         2*   0550         BCS   SETFLG    YES, SET OR CLR FLAGS
002C 98            2    0560         TYA             GET ORIGNAL CHAR AGAIN
002D 9D 38 06      5    0570         STA   ESCHAR,X  STORE NEW ESC CHAR
0030 90 16         2*   0580         BCC   DONE1     BRANCH ALWAYS TAKEN
0032 4A            2    0590 SETFLG  LSR   A
0033 6A            2    0600         ROR   A         B0 -> B7, B2 -> B0, B1 -> CARRY
0034 B0 08         2*   0610         BCS   CLRFLG    CLR FLAGS IF B1 WAS ONE
0036 1D B8 06      4*   0620         ORA   FLAGS,X   SET FLAGS SELECTIVELY
0039 10 0A         2*   0630         BPL   NEWFLG
003B A0 28         2    0640         LDY   #$28      IF IN VIDEO ALSO THEN SET
003D 84 21         3    0650         STY   WNDWDTH     WINDOW WIDTH  (MARGIN)=40
003F 90 04         2*   0660         BCC   NEWFLG    BRANCH ALWAYS TAKEN
0041 3D B8 06      4*   0670 CLRFLG  AND   FLAGS,X   CLEAR FLAGS SELECTIVELY
0044 18            2    0680         CLC             INDICATE 'NOT AFTER ESC CHAR'
0045 9D B8 06      5    0690 NEWFLG  STA   FLAGS,X   B7=VIDEO-ALSO, B0=CRLF
0048 7E B8 05      7    0700 DONE1   ROR   MODE,X    CARRY INTO B7 FOR
004B 68            4    0710 DONE2   PLA             'AFTER ESC CHAR' MODE
004C A8            2    0720         TAY
004D 68            4    0730         PLA           RESTORE REGISTERS
004E AA            2    0740         TAX
004F 68            4    0750         PLA           THEN RETURN
0050 60            6    0760         RTS
0051                    0770 *
0051                    0780 *
0051 A0 0A         2    0790 DIG     LDY   #$A
0053 7D 38 05      4*   0800 DLOOP   ADC   MSTRT,X   ADD 10*MSTRT TO DIG AND STORE
0056 88            2    0810         DEY             IN WINDOW WIDTH (MARGIN)
0057 D0 FA         2*   0820         BNE   DLOOP
```



```
0059 B5 21         3    0830         STA   WNDWDTH
005B 9D 38 05      5    0840 MINIT   STA   MSTRT,X   UPDATE MARGIN START
005E 38            2    0850         SEC             INDICATE 'AFTER ESC CHAR'
005F B0 E7         2*   0860         BCS   DONE1     BRANCH ALWAYS TAKEN
0061                    0870 *
0061                    0880 *
0061 A9 89         2    0890 DEFAULT LDA   #$89      DEFAULT CHARACTER (CONTROL-I)
0063 9D 38 06      5    0900         STA   ESCHAR,X
0066 9D B8 06      5    0910         STA   FLAGS,X   VIDEO ALSO, CRLF ON
0069 A9 02         2    0920         LDA   #>ENT1
006B 85 36         3    0930         STA   CSWL      SET FOR NORMAL ENTRY
006D 98            2    0940 ESCTST  TYA             MOVE CHAR TO REG-A
006E 5D 38 06      4*   0950         EOR   ESCHAR,X
0071 0A            2    0960         ASL   A         ESC CHAR? (7 LSB'S)
0072 F0 E7         2*   0970         BEQ   MINIT     BRANCH IF YES
0074 5E B8 05      7    0980         LSR   MODE,X    NO, CLR 'AFTER ESC CHAR'
0077 98            2    0990         TYA
0078 48            3    1000         PHA             SAVE CHAR ON THE STACK
0079 8A            2    1010         TXA
007A 0A            2    1020         ASL   A
007B 0A            2    1030         ASL   A         GENERATE N*$10 AS AN INDEX TO
007C 0A            2    1040         ASL   A           THE DEVICE LINE (REG-Y)
007D 0A            2    1050         ASL   A
007E A8            2    1060         TAY
007F 90 40         2*   1070         BCC   PRNT      BRANCH ALWAYS TAKEN
0081 90 FE         2*   1080         BCC   *-2       IMAGE 'WAIT FOR READY'
0083 99 80 C0      5    1090 OUT     STA   DEV,Y     OUTPUT CHAR TO PRINTER
0086 90 39         2*   1100         BCC   PRNT      LOOP IF WAS TAB
0088 49 0D         2    1110         EOR   #$D
008A 0A            2    1120         ASL   A         CARRAGE RETURN IN 7 LSB'S?
008B D0 0D         2*   1130         BNE   FINISH    BRANCH IF NOT CR
008D 9D 38 07      5    1140         STA   COL,X     CLEAR COLUMN COUNT
0090 BD B8 06      4*   1150         LDA   FLAGS,X   FOR CRLF CHECK (B0)
0093 6A            2    1160         ROR   A
0094 29 80         2    1170         AND   #$80
0096 09 0A         2    1180         ORA   #$A       GENERATE LINE FEED
0098 B0 5F         2*   1190         BCS   PRNT2     OUTPUT IF CRLF MODE
009A BD B8 06      4*   1200 FINISH  LDA   FLAGS,X
009D 10 08         2*   1210         BPL   NOVID
009F 68            4    1220         PLA
00A0 A8            2    1230         TAY
00A1 68            4    1240         PLA             IF VIDEO-ALSO MODE THEN
00A2 AA            2    1250         TAX               RESTORE REGISTERS AND END
00A3 68            4    1260         PLA               WITH VIDEO OUT ROUTINE
00A4 4C F0 FD      3    1270         JMP   COUT1
00A7 BD 38 07      4*   1280 NOVID   LDA   COL,X     COLUMN COUNT
00AA F0 08         2*   1290         BEQ   SETCH     IF ZERO, CLEAR CURSOR HORIZ
00AC E5 21         3    1300         SBC   WNDWDTH   CHECK FOR WITHIN 8 CHARS OF
00AE E9 F7         2    1310         SBC   #$F7        WINDOW WIDTH (MARGIN)
00B0 90 99         2*   1320         BCC   DONE2     IF NO, THEN DONE
00B2 69 1F         2    1330         ADC   #$1F      ADD 32  (FORMING 32-39)
00B4 18            2    1340 SETCH   CLC               FOR NEW CURSOR HORIZ IF
00B5 85 24         3    1350         STA   CH          NEAR MARGIN (FOR LIST)
00B7 90 92         2*   1360         BCC   DONE2     BRANCH ALWAYS TAKEN
00B9 70 FE         2*   1370         BVS   *-2       IMAGE FOR 'WAIT FOR READY'
00BB                    1380         ORG   *+6
00C1 90 21         2*   1390 PRNT    BCC   PRNT1     TAKEN WHEN PRINTER READY
00C3                    1400         ORG   *+$21
00E4 BD 38 07      4*   1410 PRNT1   LDA   COL,X
00E7 C5 24         3    1420         CMP   CH        IF COLUMN >= CURSOR HORIZ
00E9 68            4    1430         PLA               THEN USE CHAR
00EA B0 05         2*   1440         BCS   CTLTST
00EC 48            3    1450         PHA
00ED 29 80         2    1460         AND   #$80      ELSE GEN BLANK (7 LSB'S)
00EF 09 20         2    1470         ORA   #$20        FOR TAB CATCH-UP
00F1 2C 58 FF      4    1480 CTLTST  BIT   IORTS
00F4 F0 03         2*   1490         BEQ   PRNT2     INCR COLUMN COUNT
00F6 FE 38 07      7    1500         INC   COL,X       IF NOT A CONTROL CHAR
00F9 70 88         2*   1510 PRNT2   BVS   OUT       TAKEN WHEN PRINTER READY
```

```
0024  CH        0041  CLRFLG    073B  COL       FDF0  COUT1
0036  CSWL      00F1  CTLTST    0061  DEFAULT   C080  DEV
0051  DIG       0053  DLOOP     004B  DONE1     004B  DONE2
0000  ENTO      0002  ENT1      063B  ESCHAR    006D  ESCTST
009A  FINISH    06B8  FLAGS     FF58  IORTS     005B  MINIT
05B8  MODE      0538  MSTRT     0045  NEWFLG    00A7  NOVID
0083  OUT       00C1  PRNT      00E4  PRNT1     00F9  PRNT2
00B4  SETCH     0032  SETFLG    0021  WNDWDTH
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